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METHOD AND DEVICE FOR CONTROLLING THE TIME AT WHICH THE TONER CONCENTRATION IS MEASURED IN A DEVELOPER MIXTURE CONTAINING TONER AND CARRIERS, AND CORRESPONDING PRINTER OR COPIER

Electrophotographic printers or copiers are known, see for example EP 0 653 077 B1. In these, charge images of images to be printed are generated on an intermediate carrier, for example a photoconductor drum. The charge images are inked with toner and the toner images are subsequently transfer-printed onto a recording medium, for example paper. For a fixed binding of the toner images with the recording medium, these are moved through a fixing station. The inking of the charge images on the intermediate carrier ensues in a developer station whose design is, for example, known from EP 0 857 324 B1. There a developer mixture comprising, for example, toner and carrier is stirred and subsequently directed onto the intermediate carrier via developer rollers, for example magnet brushes. Toner transfers onto the intermediate carrier corresponding to the charge images on the intermediate carrier. The developer mixture falls from the carrier and the remaining toner falls back into the developer station and there is supplemented with new toner.

The determination of the toner concentration in a developer mixture comprising toner and carrier is of importance in such an electrophotographic printer or copier. There, as described above, charge images of images to be printed are generated on the intermediate carrier, which charge images are inked with toner in the developer station. In order to obtain an acceptable print image, the toner concentration in the developer mixture comprised of toner and carrier must be adjustable. For this it is necessary that the toner concentration in the developer mixture is known.

An example of a part of such an electrophotographic printer or copier can be learned from DE 197 42 668 A1 or EP 0 563 077 B1; it is shown in Fig. 1. Charge images of images to be printed are generated on a photoconductor drum 1, which

charge images are inked with toner in a developer station 2. For this, in the developer station 2 a developer mixture is poured into the intake for toner 6, which developer mixture falls into a developer sump 4. The developer mixture is stirred in a mixing device 7, here by a bucket roller 3. The bucket roller 3 transports the developer mixture close to a developer roller 5/1 that takes up the developer mixture and moves it to a further developer roller 5/2. The developer rollers 5 develop the charge images on the photoconductor drum 1 in a known manner. The bucket roller 3 comprises buckets 8 that serve to transport the developer mixture. Since toner is drawn from the developer mixture via the development of the charge images, it is necessary to supply new toner. This ensues via the intake 6. In order to adjust the quantity of the toner to be supplied, the toner concentration in the developer mixture must therefore be determined.

The content of EP 0 653 077 B1, EP 857 324 B1, DE 197 668 A1 and their respective corresponding disclosures is herewith incorporated by reference into the present specification.

In US 2001/053 293 A1 and US 6 212 341 B1 it is described how the toner concentration can be measured in a developer station. The developer is moved in one direction by an outer mixing screw with helices and in the opposite direction by an inner mixing screw. To measure the toner concentration, underneath the mixing screw a toner concentration sensor is arranged onto which the toner falls from the mixing screw and deposits there. The toner concentration sensor then measures the toner concentration at a point in time at which the toner deposit on the toner concentration sensor has reached a maximum. In order to enable a repeated measurement, a scraper is attached on the mixing screw that rotates with the mixing screw and abrades the toner from the toner concentration sensor. The sensor signal emitted by the sensor then has a minimum when the toner has been abraded from the sensor. This minimum is fixed and the measurement is implemented, derived from this, after a delay period.

The problem to be solved by the invention is to specify a method and an arrangement via which the toner concentration in the developer mixture is measured with less effort and nevertheless reliably.

This problem is solved according to the features of the independent claims.

It is appropriate to arrange the toner concentration sensor in the mixing device and in fact adjacent to the bucket roller. The toner concentration is then measured at the point at which new toner is mixed into the developer mixture. The sensor signal emitted by the toner concentration sensor and indicating the toner concentration can be evaluated with regard to the toner concentration. For this it is necessary to establish the point in time of the measurement or, respectively, a measurement window. Since a pulse-shaped spike (that is essentially caused by the bucket and not only by the toner concentration) occurs in the sensor signal upon a bucket of the bucket roller passing by the toner concentration sensor, it is advantageous when the measurement window is set in the time range between such pulse-shaped spikes in the sensor signal.

Developments of the invention result from the dependent claims.

In order to correspondingly place the measurement window, it is necessary to determine the temporal position of the pulse-shaped spikes in the sensor signal. For this, it can be established that, when the sensor signal exhibits its largest rise, this lies at a pulse-shaped spike. To establish the rise, the sensor signal can be sampled at the same temporal interval and the determined amplitude values can be examined as to whether they exceed a predetermined threshold. Or, the difference of successive amplitude values of the sensor signal can be generated and the difference with the largest value can be drawn upon to indicate the position of the pulse-shaped spike.

When the temporal position of one or more pulse-shaped spikes is determined in the sensor signal, the measurement window can be placed such that it comes to lie between two pulse-shaped spikes. In a simple manner, a delay period that must be added onto the point in time of the occurrence of a pulse-shaped spike in order to arrange the measurement window between two pulse-shaped spikes can be determined from the rotation speed of the bucket roller given knowledge of the position of the pulse-shaped spikes. Naturally, the points in time of the occurrence of the pulse-shaped spikes can also be determined and the measurement window correspondingly placed. A trigger signal that can be used to control the measurement window can be derived from the temporal position of at least one of the pulse-shaped spikes.

If the magnet rails should be arranged on the buckets of the bucket roller in order to keep the mixing device free of toner deposits in the bucket roller region, it is then advantageous to remove the magnet rails in the region of the toner concentration sensor in all buckets except for one. The result is that a particularly pronounced pulse-shaped spike occurs in the sensor signal when the bucket with the uninterrupted magnet rail passes the toner concentration sensor while the pulse-shaped spikes are less pronounced with the other buckets.

If no pulse-shaped spike should occur during a revolution of the bucket roller, an error exists. In this case, it is appropriate to generate a trigger signal independent of the curve of the sensor signal, which trigger signal controls the measurement window. Such an error case can be detected with an error counter. This is incremented when no pulse-shaped spike occurs during a revolution of the bucket roller and decremented when a pulse-shaped spike occurs again in the next revolution. This error counter can be used in an advantageous manner in order to establish whether the mixing device exhibits a continuous error. When the counter state exceeds a predetermined value, this can be assessed as a circumstance that the mixing device operates incorrectly and the printing operation can then be aborted.

In a further embodiment of the invention, a trigger signal for control of the measurement window can be acquired with the aid of a sensor device that is built from a magnet arranged at the shaft of the bucket roller and a fixed Hall sensor. When the magnet passes the Hall sensor, this generates the tigger [sic] signal that controls the opening of the measurement window. In order to eliminate manufacturing tolerances, it is appropriate to determine once the temporal interval between trigger signal and occurrence of the next pulse-shaped spike in the sensor signal and, in operation, to open the measurement window when the simulation of the above temporal interval and a predetermined delay period has elapsed. Instead of the sensor device with a Hall sensor, a light barrier or a switching contact can also be used to generate the trigger signal.

The invention is explained further using exemplary embodiments that are shown in Figures. Thereby shown are:

Fig. 1 a developer station known from DE 197 42 668 A1;

Fig. 2 the curve of the sensor signal in an arrangement without Hall sensor;

Fig. 3 the curve of the sensor signal corresponding to Fig. 2 for the case that no pulse-shaped spike occurs during a revolution of the bucket roller;

Fig. 4 the curve of the sensor signal for the case that a Hall sensor is used to generate the trigger signal; and

Fig. 5 a principle representation of the bucket roller; [sic]

A developer station 2 in which a mixing device 7 is provided with a bucket roller 3 results from Fig. 1. The developer mixture is continuously stirred with the aid of

the bucket roller 3, which is provided with buckets 8. Magnet rails 9 that should keep the bucket roller region free of toner are arranged on the buckets 8. In Fig. 1, a plurality of buckets are provided; for explanation of the invention, it is sufficient that, corresponding to Fig. 5, three buckets 8a, 8b, 8c are used. The magnet rail 9 is arranged on one of the three buckets (for example 8a) while the magnet rails in the region of the toner concentration sensor 10 are disconnected on the other buckets. The radial position of the toner concentration sensor 10 results from Fig. 5; it is clear that this is adjacent to the buckets 8 of the bucket roller 3. The toner concentration sensor can be realized as an inductive sensor.

The curve of the sensor signal SS emitted by the toner concentration sensor, plotted over the time t over a rotation of the bucket roller 3, results from Fig. 2. From the curve of the sensor signal SS it is to be learned that this exhibits pulse-shaped spikes SP upon the buckets of the bucket wheel passing by the remote control sensor, however in the remaining region shows a curve determined by the toner concentration.

In addition to the curve of the sensor signal SS, the curve of the difference values DF is shown plotted over the time t. These difference values DF are determined in that the amplitude values of the sensor signal SS are determined at fixed points in time ZP, the amplitude values of successive points in time are subtracted from one another, and the difference values DF are checked as to when they cross a threshold SW1. When this is the case, a trigger signal identifying the temporal position of the pulse-shaped spike can be emitted. However, it is also possible that the trigger signal is emitted when the sensor signal crosses a predetermined threshold SW2 or has reached its peak value. Furthermore, it is possible that the trigger signal is emitted when the difference value DF has reached a maximal value and therewith has reached the greatest rise. Or, the trigger signal can be emitted when a*SS+b*DF > SW, whereby a and b are selectable constants.

The points in time of the sampling of the sensor signal are plotted over the time t in Fig 2; the interval between the sampling points in time remains constant. The difference of the amplitude values between two sample points in time is designates with x(n)-x(n-a), whereby n is the index of the current measurement value, a is the increment that can be selected, for example with a = 5.

From the example of Fig. 2, it can be learned that the sensor signal SS exhibits a pulse-shaped spike SP1 during a rotation of the bucket roller 3, which pulse-shaped spike SP1 is associated with the bucket 8a provided with a magnet rail 9. The remaining two buckets 8b, 8c without magnet rails in the scanning region generate only small pulse-shaped spikes SP2, SP3 that are below the predetermined threshold SW.

As results from the curve of the sensor signal SS, in the above case (in which only one bucket is provided with a magnet rail in the sampling region) a measurement window MF that lies after the bucket 8b following the passage of the bucket 8a generating the trigger signal is advantageous for the measurement of the toner concentration. In particular the sensor signal is then least disturbed by the buckets. The measurement window MF can then be controlled by the trigger signal, whereby it can be opened when a predetermined time has elapsed after occurrence of the trigger signal.

The case that no pulse-shaped spike SP has occurred in the sensor signal SS during a rotation of the bucket roller 3 results from Fig. 3 (shown again is the curve of the sensor signal SS and the curve of the difference values DF plotted over the time t). Initially the case is shown in which the pulse-shaped spike SP1 exists as in the error-free case; subsequently shown is the situation in which a pulse-shaped spike no longer appears (region II). When this situation is given at least during one rotation of the bucket roller, a trigger signal that controls the measurement window MFE is compulsorily generated independent of the curve of the sensor signal. The compulsory triggering is advantageously implemented so that the forced

measurement window MFE comes to be situated one rotation later than the measurement window MF.

The occurrence of such error cases can be monitored with the aid of an error counter. Each time when no pulse-shaped spike occurs during a revolution of the bucket roller, the error counter is incremented by a unit; when a pulse-shaped spike subsequently appears again, the error counter is decremented by a unit. If the error counter should exceed a predetermined numerical value, an error signal is generated that indicates that the mixing device operates incorrectly.

A principle representation of a bucket roller 3 with three buckets 8a, 8b, 8c results from Fig. 5. A magnet rail 9 is mounted on one bucket 8a, while the other buckets 8b, 8c comprise no magnet bar in the region of the toner concentration sensor 10. The rotation direction of the bucket roller is shown by an arrow. A magnet 11 is arranged on the shaft 13 of the bucket roller, outside of the mixing device; a Hall sensor 12 is arrange adjacent to the magnet 11. When the magnet 11 passes by the Hall sensor 12, this generates a trigger signal that can be drawn upon to control the measurement window MF.

Fig. 4 shows the course of the sensor curve SS given one revolution of the bucket roller 3. The point in time TZ at which it [sic] Hall sensor emits the trigger signal is designated. Furthermore, the point in time of the occurrence of the pulse-shaped spike SP1 in the sensor signal is indicated. The measurement window MF is opened, calculated from this point in time on, after expiration of a delay time t(Delay) dependent on the rotation speed of the bucket roller. In order to be able to control the point in time of the opening the of the measurement window MF from the trigger signal, the time interval t(Excavator) [sic] of trigger signal – occurrence of the pulse-shaped spike must be determined defined [sic]. It is therefore appropriate to determine the temporal interval t(Excavator) once for each mixing device. The point in time at which the measurement window is opened can subsequently be determined via addition of the time interval t(Excavator) with the

predetermined delay value t(Delay). The temporal position of the pulse-shaped spike SP can be established as explained above.

In contrast to the embodiment according to Fig. 2, in Fig. 4 the pulse-shaped spike SP must only be determined once. The opening of the measurement window MF is subsequently implemented after the time t(Excavator)+t(Delay) since both values no longer change. The opening of the measurement window MF can thus be controlled solely via the trigger signal generated by the Hall sensor. If the Hall sensor should fail, a compulsory triggering can be generated as described above.

The evaluation of the sensor signal or, respectively, of the difference values can occur according to software and/or with the aid of standard electronic components.

Reference list

1	photoconductor drum
2	developer station
3	bucket roller
4	developer sump
5	developer roller
6	intake for toner
7	mixing device
8	bucket
9	magnet rail
10	toner concentration sensor
11	magnet
12	Hall sensor
13	shaft of the bucket roller
SS	sensor signal curve
SP	pulse-shaped spike of the sensor signal curve
SW	threshold
DF	difference value
t	time
MF	measurement window
ZP	sampling point in time
MFE	compulsory measurement window
TZ	point in time of the occurrence of the trigger signal
t(Excavator)	time between the occurrence of the trigger signal and occurrence of the next pulse-shaped spike
t(Delay)	delay period